



BANGALORE ELECTRICITY SUPPLY COMPANY LIMITED

(Wholly owned by Government of Karnataka Undertaking)

UNDER GROUND CABLE FAULT DETECTOR FOR BRAZ & CTAZ AREA

TECHNICAL SPECIFICATION FOR SUPPLY OF VEHICLE MOUNTED FULLY AUTOMATIC HT & LT UG CABLE FAULT LOCATING EQUIPMENT UP TO 33kV FOR BRAZ & CTAZ AREA.

1 SCOPE:

- 1.1 This specification is intended to cover the design, manufacture, assembly, testing at manufacturer's works, supply, delivery, installation & commissioning of Special General-Purpose Van Mounted Fully Automatic Cable Fault Locating Equipment Suitable for Locating Fault on Low /Medium / High Voltage underground Power Cables up to 33 KV Complete with all materials and accessories for efficient and trouble-free operation.
- 1.2 All functions should be centrally controlled and monitored via integrated industrial PC running on users friendly based Operating System with suitable Anti-virus and cyber security.
- 1.3 **Standards:** The equipment shall confirm to the latest edition of the relevant standards. Bidders shall mention the applicable standard and shall furnish two copies of authenticated English version of the standards along with the offer

2 Functions of the system

- 2.1 The following functions should be performed and controlled via fully automatic centrally controlled unit by using single button/click
 - Integrated Insulation testing
 - DC Testing
 - Pre location of Fault.
 - Breakdown Voltage recognition.
 - Sheath testing and sheath fault location
 - Pin pointing of Fault.

Continuously variable surge generator in steps of 0 to 4, 8, 16, 32 kV with 1100J or more @ 4KV and **2000** joules or more @ 8/16/32KV

2.2 Fault pre-location methods

- Sectionalizing method/ Intermittent Fault Location
- Insulation resistance method
- Time Domain Reflectometry Method (TDR)- 3 Phase
- Capacitive Discharge (Thumping)
- SIM/MIM – Secondary/ Multiple Impulse method
- Surge Arc reflection/ Arc Reflection Method
- Burn ARC reflection/ ARM Burning (min 25Amps)
- Impulse current method (ICM upto 32kV)
- Decay method- Voltage coupled decay method (upto40kV)
- Other fault locating techniques if any.

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2.3 **Pin-pointing methods:**

- Acoustic pin-pointing
- Audio frequency-based pin-pointing
- Step voltage method
- Wireless connectivity pin pointing set
- Cable tracing

2.4 **System software:**

- a) The cable fault analysis shall be done automatically via a software controlled fully automatic mega-ohm meter with integrated 10KV or above IR – test voltage and a powerful 3-Phased Time Domain Reflection measurement (TDR).
- b) The fault pre-location system must be integrated part of the entire system providing simultaneous control of system, HV generator and cable fault location function.
- c) Automatic features should guide and support the operator during the complete fault location and testing procedure.
- d) The system shall be based on a solid industrial PC design, equipped with comparable processor and shall use operating system for easy data communication and handshaking with other systems. The TDR should use at least 400MHz data rate and a high dynamic range.
- e) The three phased TDR output must provide at least CAT IV/400V input protection.
- f) The Cable fault location function shall be guided by a Cable Fault Location Guide that guides the operator through the entire process of cable fault location.
- g) All software functions for fault analysis, cable fault pre-location, control for fault pinpointing, and shall be controlled via a Single rotary knob/Key board or mouse.

2.5 **Cable Fault Location Guide**

The Cable Fault Location Guide should be designed to guide operators through the cable fault location and testing process. Just by entering the most common cable parameters; such as nominal voltage, cable length and the available details from the manufacturer Cable Data Base, the system should determine the correct test parameters and procedures which then only need the final confirmation for application of the operator.

All performed test and measurement results shall be considered for the next following steps of the fault location approach and finally should be automatically saved in the memory and become part of the fault location sequence.

Reporting function should require few clicks to generate a final report.

- A Cable Fault Location Guide should lead the user step by step – quickly and efficiently – to the cable fault.
- It shall be an intelligent fault location process to help the operator by adjusting the proposed fault location procedure in dependence of the fault situation.
- The automatic fault analysis should provide clear graphical presentation and thus a good overview for the user.
- Facility for user configurable voltages levels shall be provided.

- The automatic cursor positioning function shall indicate the cable end and the fault position.
- Facility for automatic setting of method-related parameters such as pulse width, gain, pre-trigger, view range, etc. for fast and efficient fault location shall be provided.
- Clear graphical presentation of the measurement results with helpful functions such as zoom, superimposing of multiple graphs, individual curve movement for the analysis is required.
- Facility shall be given to the user to deviate in any part of the fault process instead of following the recommendation.
- The system shall have over voltage and under voltage protection of mains supply and HV should not get ON in case of over and under voltage.
- Memory: Automatic storage of data and a min of **1,00,000** data storage facility of all test data shall be provided.
- The entire system shall be mounted on suitable vehicle with back door safety, during the operation if door gets open accidentally then instrument should sense it & stop the HV immediately
- Mounting Van for the Comprehensive Set: All the Units of the Comprehensive Van Mounted Multifunctional Cable Fault Locator system consisting of Cable Fault by ARM burn unit, Pre-Location, Pin-pointing & Testing of HT & LT cables shall be mounted on a suitable frame with Power Supply connection arrangement in suitable white board Vehicle if Diesel Driven with authorized modification certificate.
- Local service Engineer should be available in the jurisdictional area for giving service support.

2.6 **The offered system should consist of several functional modules**

These are:

- Central Control Unit
- Mains & Safety Control Unit
- Industrial PC with user friendly manufacturer System Software with UPS.
- 3 Phase Time domain reflectometer
- LV connector panel
- HV coaxial connection sockets
- Cable drum rack with connection cables
- Operating desk with drawers
- Fully Automatic Multi-Functional Surge Generator

3 **TECHNICAL PARAMETERS REQUIRED IN THE SYSTEM**

3.1 **Function of the system**

The following functions has to be performed and controlled via fully automatic centrally controlled unit by using single button/click

- a) Integrated Insulation testing with range of 10kV-15kV or more
- b) DC Testing
- c) Pre location of Fault
- d) Breakdown Voltage recognition
- e) Sheath Testing - Min 10kV

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3.2 **Fault pre-location with following methods**

- a) Time Domain Reflectometry-3phased TDR
- b) Pulse Reflection Measurement
- c) Arc Reflection Measurement / Multiple Impulse method
- d) Impulse Current Method (ICM)
- e) Decay- Voltage decay method
- f) Burn Arc Reflection with voltage of 15kV and Current of 25Amps or above
- g) Other fault locating techniques if any.

3.3 **Pin-pointing methods consisting of following features**

- a) Acoustic pin-pointing
- b) Audio frequency-based pin-pointing
- c) Step voltage method
- d) Cable tracing
- e) Re-chargeable battery cells with charger

3.4 **System Software with following parameters**

- a) The cable fault analysis has to be done automatically via the inbuilt latest user friendly interface with suitable operating system free from virus/cyber-attacks which is controlled fully automatic mega-ohm-meter with min 10KV IR- test voltage and a powerful 3 phased Time Domain Reflectometer (TDR).
- b) Automatic features have to guide and support the operator during the complete fault location and testing procedure.
- c) The system has to be based on a solid industrial PC design, equipped with appropriate latest high speed comparable processor and shall use user friendly operating system for easy data communication and handshaking with other systems. All control should be through single rotary knob/key board mouse facility.
- d) Any up gradation in the software in future after supply, life time software assistance support shall be provided by supplier without claiming any extra charges.

3.5 **Pre-Locator with following parameters:**

- a) TDR pulse width: **20ns – 10 Micro sec** or more
- b) Measuring pulse: **Bipolar ±100 V**
- c) Output impedance: **50 Ohm or more**
- d) Sampling rate: **400 MHz or more**
- e) Input signal gain: Dynamic range min 105 dB
- f) SIM/MIM/ARM: **Min 30 TDR** multi-shot measurements
- g) Display range: **20m – 300 km** or more
- h) Resolution (@ $v/2 = 80 \text{ m}/\mu\text{s}$): 0.1 m
- i) Accuracy: 0.1% of measuring result
- j) Propagation velocity factor $v/2$ range: 20 – 150 m/ μs adjustable.
- k) Size of screen: 15" or more
- l) Monitor: LCD/LED display
- m) Ambient temperature (operational): 0 to +50 °C
- n) Storage temperature: -20 to +60 °C
- o) Power supply: 100 – 260 V, 50/60 Hz
- q) IR test:
 - Test voltage: upto 10kV or more
 - Measuring range: up to min 650 Mega- Ohm and simultaneously measuring Phase to Phase and Phase to Neutral. (L1/N, L2/N, L3/N, L1/L2, L2/L3 & L1/L3)

- 3.6 **A. Surge Voltage Generator with following parameters:**
0-4, 0-8, 0-16, 0 - 32 kV Surge Energy: 1100J or more at 4KV and **2000J** or more @ 8/16/32KV
DC Voltage: 0 - 40 KV
Surge sequence: 6- 20 surges/min., single surge

B. Surge Generator Unit:

- (a) Surge Voltage Range: 0- 4KV, 0-8 KV, 0-16 KV & 0-32 KV
- (b) Surge Energy: 0-4kV: 1100J or more & 0-8, 0-16, 0-32 KV: 2000 J or more
- (c) The set should be provided with standard safety features like, 'High voltage ON lamp', automatic grounding upon shutdown, Auto-OFF in case of power supply break and overload protection with circuit breaker etc.
- (d) The unit should be compatible for use with Surge Receiver Unit and Arc Reflection Unit.
- (e) The unit should include mains leads, earth cable, HV connecting cable, earth terminals, battery connecting cables with battery clips, all required and related accessories with carrying case and user's manual with complete operating and maintenance instructions.
- f) Impulse: 0-32 kV in suitable steps of 0-4/0-8/0-16/0-32 kV and each step continuously variable.

C. Safety Protection:

- 2 automatic Internal & External discharging devices
- Reliable operated surge switch electromagnetic operated
- Safety control circuit according to VDE 0104

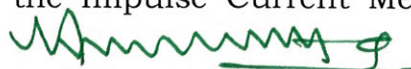
3.7 **Filter unit for SIM/MIM/ARM:**

Since pulse echo or reflection may not be suitable for high impedance or resistance faults. Thus, keeping in view, a suitable band pass filter unit should be supplied to stabilize the ARC at the flashover or the point of fault.

The offered filter must simplify the operation causing less stress, causing minimum damage on the tested cables to detect the high resistive faults. There should be complete compatibility of TDR, Surge Generator/Thumper with the filter unit. This unit must filter or stabilize the arc at the fault point and record the same in the supplied TDR to compare it with previous trace recorded without the filter unit in the same core. Suitable coupler for coupling the filter unit with the TDR and Surge generator must be supplied. The offered filter must contain switching elements necessary for the triggering and the coupling of the pulse. After the pre-location using the SIM/MIM/ARM method, there must be a decoupling element which must by pass the surge generator for making it ready for use in pinpointing the cable fault. The control unit should connect automatically the filters with appropriate coupler with the surge generator and TDR when SIM/MIM/ARM mode.

3.8 **Inductive coupler:**

Inductive Coupler required for pre-location of high resistance faults with a Surge Voltage Generator according to the Impulse Current Method (ICM)/ARM.



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3.9 **Capacitive coupler:**

Capacitive voltage divider required for location of intermittent cable faults up to 40 KV DC to perform the Decay Method.

3.10 **Integrated Fault Conditioning Unit:**

This set should be capable for conditioning of high resistive faults in cables to facilitate the fault relocation. The fault conditioning Unit should have the following features:

- a) The voltage range shall be max **15kV DC and current of 25A or above.**
- b) The fault conditioning unit should communicate with the main system for the intelligent Burn Arc/ARM burning mode.
- c) The unit should live ARM burning graph and should give the ARM graph on detection of fault break be integrated with central control system. The arcing is monitored with a TDR, which is connected to the cable through an HV coupler. The distance to the fault is measured using standard TDR techniques. Current tracing is usually used to verify the location of the fault. The resonance burn set should be capable of ionizing the fault and maintaining a burn current of at least 25 A
- d) Link shall be given to activate the pre location at any time during conditioning.
- e) The Unit should be provided with a thermal overload protection and should have auto-reset feature.
- f) The Unit should be provided with safety earthing facility for safe operation.

3.11 **Surge Wave Receiver Unit /Pin pointer – 2 sets**

It should function as a directional acoustic listening device for pinpointing of flashover faults in underground power cables. It should have the following features:

1. The unit should be handy & rugged, and should comprise of receivers, headphones, sensors, amplifiers and any other auxiliary item as necessary for operation of the unit. The set should provide detection of both acoustic and electromagnetic pulses emitted from an arcing fault when it is surged.
2. The set should be able to determine the proximity and direction to the cable fault by measuring electromagnetic surge and acoustic emission.
3. The set should be able to measure the time delay between acoustic and electromagnetic signals.
4. In acoustic mode the set should have Automatic Noise Suppression feature to eliminate complete background noise.
5. It should be able to pinpoint the exact location of the fault.
6. The instrument should be rechargeable battery operated.
7. The set should have mute feature to activate while in motion.
8. It should have adjustable feature for adjusting the electromagnetic gain & acoustic gain.
9. It should have an LCD display with backlit feature.
10. The unit should be provided with acoustic headphone set to receive the acoustic signal for pin pointing the fault point.
11. The LCD display should indicate the cable route through the electromagnetic signal in bar graph form & the proximity to fault point by a numeric display.

12. The communication between receiver instrument and ground microphone shall be done via a Wired/wireless connection. The communication between the head phone and receiver instrument should be wireless.
13. The unit should include lightweight receiver with carrying straps, handy sensor, all required and related accessories with carrying case and user's manual with complete operating and maintenance instructions with following features:
 - a) Acoustic method including manhole distance location
 - b) Digital indication of proximity of the fault
 - c) Water-resistant design
 - d) Integrated headphone
 - e) Large, illuminated LCD display
 - f) Automatic digital filters for suppression of traffic noise
 - g) Easy menu operation
 - h) Lightweight
 - g) Accurate route tracing and cable depth measurement.

3.12 **The offered system consisting of following functional modules**

- a) Central Control Unit
- b) Mains & Safety Control Unit
- c) Industrial PC with operating system with UPS
- d) 3 phase Time domain reflectometer (TDR)
- e) LV connector panel
- f) HV coaxial connection sockets
- g) Cable drum rack with connection cables
- h) Operating desk with drawers
- i) Fully Automatic Multi-Functional Surge Generator
- j) Cable Database that allows the creation of specific cable details database, its history, testing results
- k) Cable fault location Guide as mentioned in above under clause 2.6

3.13 **Safety Measure:**

The control unit should be Computerized (menu driven) based and responsible for all the control operation of various functions such as Mode Selection Surge Test, Conditioning and Arc Reflection, Range Selection, Voltage limit adjustment, Surge sequence selection, auto discharge, earth monitoring, etc. from the central software and no access to the high voltage side should be available to the operator as well as operator guidance with on-screen help texts.

The control unit should provide visual indication of failure of safety circuits/incorrect selection etc. with possible corrective methods. Constant monitoring of all safety circuits such as earth monitoring circuit etc. should be inbuilt into the control unit, safety interlock monitoring etc. Safety function should be incorporated in the vehicle suitably.

The instrument should have a built-in automatic discharge feature as per which a cable (installation) has to be safely discharged after a high voltage test. An emergency button on surge generator shall be provided to disconnect all equipments. All equipments shall be discharged on supply failure of disconnection of the unit.

The system shall be designed in such a way so as to be mountable on a vehicle in such a way that the operating personal safety is ensured by strict separation of operating equipment and high voltage compartment.

Input voltage proof display up to 400V and current drawn by the equipment display is necessary.

Fuse units for each circuitry is essential and also be easily accessible so as to enable the operator to replace the fuse unit if required.

The equipment should not operate High Voltage, unless proper earthing is provided.

The suitable protection unit shall be provided to equipment in case of testing of energized cable. (HV protection shall be provided to the equipment).

3.14 Mounting Van for the Comprehensive Set:

All the Units of the Comprehensive Van Mounted Multifunctional Cable Fault Locator system consisting of Cable Fault conditioning (burn-down), Pre-Location, Pin-pointing & Testing of HT & LT cables shall be mounted on a suitable frame with Power Supply connection arrangement in suitable white board if diesel driven Vehicle with authorized modification certificate

3.15 Mounting, Pre wiring and Mechanical fittings on Van:

Steel frame for mounting the following instruments:

- i) Computer Aided fault locator
- ii) High pressure test: All the equipment should be mounted on steel frames.
- iii) Rotating cable drums should be provided for:
 - HV cable drum -50m or more
 - Mains cable drum -50m or more
 - Earthing cable drum-50m or more
 - Auxiliary earthing drum-15m
 - TDR measurement cable drum-25m
- iv) Safety screens be provided to isolate the HV area from operating area.
- v) Suitable cupboards and tables for storing hand held instruments, writing desk.
- vi) Diesel driven van/EV/CNG
- vii) Fully Insulated floor for safety.

3.16 Fabrication of CABLE FAULT LOCATING equipment shall be on Force TEMPO Traveller/TATA Winger or equivalent vehicle, EV/Diesel/ CNG.

Vehicle will be fabricated as per standard fabrication practice as specification confirming to All India Motor Vehicle's Act.

Provisions of standards fitment will be kept such as first aid box, Fire Extinguishers, Rear Bumpers, Stephaney, cradle, Tool box, Rear view mirrors, reverse camera, operator chair and seating arrangements for 3 Nos. AC (working on external supply), side indicators 02 Nos. Fans working on DC, proper illumination in the van and other necessary tools & accessories if any. The Stickers/ Branding of Company name with logo (BESCOM) (will be intimated in the Purchase order) and etc.

The registration of vehicle shall be of white board only, if Diesel driven Vehicle with authorized modification certificate from RTO shall be produced along with vehicle documents.

3.17 **Generator-set:**

Generator set, space for generator set and necessary wiring shall be provided for 3.3kV Generator with suitable fabrication for mounting.

3.18. **Mandatory Tools:**

- a) Discharge rod
- b) Measuring wheel
- c) Earth spikes
- d) Digital multi-meter 5KV
- e) Set of spanners, screw Driver, Allen Key set, Safety Hand Gloves shall withstand capacity upto 32kV (2 sets) etc.,

3.19. **I. Others:**

Vehicle shall be fabricated as per standard fabrication practice as specification confirming to All India Motor Vehicle's Act.

Provisions of standards fitment shall be kept such as first aid box Fire Extinguishers, Rear Bumpers, Stephaney, cradle, Tool box, Rear view mirrors, reverse camera, operator chair and seating arrangements for 3 Nos. AC (working on external supply), side indicators 02 Nos. Fans working on DC and proper illumination in the van. The Registration of vehicle shall be **white board** only if Diesel Driven, Stickers/Branding of Company name with logo (BESCOM) (shall be intimated in the Purchase order) and etc.

II. Guarantee (For Vehicle):

Notwithstanding to that specified in this Specification, the supplier is responsible to provide all necessary component for satisfactory working of the system in locating the fault in the cable. The vehicle should be Guarantee as per the Manufacturers Specifications. The supplier shall have to offer to BESCOM the same standard guarantee card of the principal manufacturer of the vehicle. Registration of the vehicle in shall in the name of allotted division /Circle with white board

III. Guarantee:

The equipment shall be **guaranteed** for the satisfactory performance and against failure due to bad design, bad materials and defective manufacturer or bad workmanship for a period of 60 months with 10% total contract value as performance Bank guarantee payable at Bangalore from the date of commissioning. The supplier shall repair / replace the faulty equipment / components free of cost in case of failure during the guarantee period. Further, all the supplied cable fault locating machines to have comprehensive onsite guarantee (inclusive of parts and labor) for 5 years 6 months from the date of supply or 5 years from the date of installation & commissioning.

IV. Certificate and instruction book.

The following documents shall be given in English along with each equipment.

- Printed pamphlets /Catalogues.
- Instruction manuals.
- Drawings (Layouts and circuit diagrams) etc. of each and every unit and sets
- Test certificates
- Guarantee card



- Copy of type test reports of the equipment
- Any other relevant documents

V. General:

1. The supplier should forward relevant technical data and operating manual of the equipment offered.
 2. A list of various clients to whom similar equipment's are supplied also may be sent with the offer.
- A) **Service Centre:** The Manufacturer shall have Full-fledged service facility operational in India to provide necessary service. The supplier shall attend and repair the equipments after receiving the calls/complaints within 24 Hrs of written/Email/Telephonic complaint and faulty spares shall be replaced within 15 days from the date of complaint.
- B) **Service Engineers:** The supplier shall provide good and qualified service engineers to assist BESCO employees during the guarantee period hereafter.
- C) **Spares:** The service centre should be equipped with sufficient spares which suits the equipment's for a minimum period of ten years.
- D) **Training & familiarization programme:** The supplier shall provide on-site training and familiarization programme at free of cost to the BESCO employees as per specification, guaranteed technical particulars of all equipment and operational functions of all accessories. The training / familiarization programme period shall be a minimum period of two weeks and it should also cover trouble shooting techniques in the equipment's/ accessories/ field for locating cable fault. Training and familiarization programme has to be arranged as and when requested by BESCO at free of cost.

VI. Inspection:

The stages of manufacturing process of equipment shall be inspected/tested/witnessed in the presence of BESCO Engineers at original equipment manufacturer's (OEM's) premises. After completion of manufacture the equipment shall be inspected/ tested/ witnessed in the presence of BESCO Engineers at supplier/ manufacturer's premises. The test shall be conducted as per relevant standards. The entire cost towards testing shall be borne by the supplier. The supplier shall intimate 30 days in advance for inspection/ testing to BESCO, to arrange for the same.


General Manager (El.)
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